INTRODUCTION TO ELECTRICITY

AG 130-Q

UNIT OBJECTIVE

After completion of this unit, students will be able to understand basic electricity, understand electrical measurements in watts, ampere, volts, and ohm. This knowledge will be demonstrated by completion of assignment sheets and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Use approved safety measures in electrical wiring.

2. Select correct fuses & circuit breakers for a given circuit.

3. Select wire sizes for a given circuit.

4. Define ampere, watt, volt, and ohm

5. Exhibit safe habits when working around electricity.

6. Understand the difference between electrical flow of 240 volts and 120 volts in wiring.

PRINCILES OF ELECTRICITY

A. Basic Theory of Electricity

1. What is electricity?

    a. Electricity is the flow of electrons, threw a conductor, from a positive to a negative charge.
    b. It can be generated, transmitted, and controlled.

2. Where does electricity come from?

    a. Electricity is present in all matter.
        1) All matter is made of combinations of elements called molecules, which are in turn made up of even smaller units called atoms.
        2) An atom is the smallest amount of an element that retains all the properties of the element.
        3) An atom may be broken down into smaller pieces whose relationships have been conceived of as a miniature solar system.

            a) The center of the atom consists of protons, which carry a positive electrical charge, and neutrons, which carry no charge.
            b) Electrons, which carry a negative electrical charge, orbit around the center of the atom.
            c) Two kinds of electrons exist:
            Planetary electrons cannot be readily moved from their orbits.
            Free or valence electrons are loosely held in the atom's outer orbit and may drift into orbits of nearby atoms.
            d) When an atom has an equal number of protons and electrons, it is said to be electrically neutral.

3. How is electric current produced?

    a. An atom becomes electrically charged when it has fewer electrons than protons.
    b. The random wandering of valence electrons from one atom to another does not produce any permanent changes.
    c. The overall material will remain the same if no outside influence disturbs the balance.

d. If an outside force, such as a battery voltage, disturbs the balance, the loosely-held outer electrons will tend to move in one direction.

1) When voltage is applied across the ends of a conductor, the electrons, which up to then had been moving in different directions, are forced to move in the same direction along the wire.
2) The individual electrons all along the path are forced to leave their atom and travel a short distance to another atom that needs an electron.
3) This motion of electrons is transmitted along the path from atom to atom, as the motion of a whip is transmitted from one end to the other.

e. This nonrandom flow of electrons is called an electric current.
f. When the free electron move randomly, their energy is small, but when they are forced to move in the same direction, their collective energy is large and can be used for work.

B. Measuring Electric Current

1. Electron Flow (Amperage)

a. An electric current is a flow of electrons along a conductor.
b. The speed of this flow is nearly equal to the speed of light, 186,000 miles per second.
c. The flow of electricity is measured by the number of electrons that pass a point in a wire in one second.
d. An ampere is a measure of electron flow; it represents a flow of 1 coulomb of electricity (6.25×10^{18}) past a point in a wire in one second. Measured in a unit called amps and is abbreviated with the letter symbols I or A.
e. Compared to a water system, an ampere would be similar to a measure of water flow through a pipe, such as gallons per minute.

2. Electromotive Force (Voltage)

a. Electromotive (electron-moving) force or voltage is electrical potential which provides energy for the movement of electrons in a circuit.
b. This electrical potential results from a difference in electron energies at two points in a circuit.

c. This difference in electron energy levels in a circuit can be compared to the potential energy of water stored in a high water tower and the kinetic energy of water flowing through the pipe.
d. Voltage is measured in units called volts (a difference variable) and is abbreviated with the letter symbols E or V.
e. Compared to a water system, a volt would be similar to a measure of water pressure in a pipe, such as pounds per square inch.

3. Resistance to Current Flow (Resistance)

a. Resistance is the ability of a material to resist electron flow.
b. Materials vary in their number of valence electrons and in the ease with which electrons may be transferred between atoms.
c. A conductor is a material through which electrons can flow freely.
d. An insulator is a material that provides great resistance to electron flow.
e. A semi-conductor is a material with poor conductivity and cannot be used as an insulator.
f. Resistance is measured in units called ohms.
g. The symbol for resistance is R, and the symbol for ohms is the Greek letter omega (Ω).

4. Energy (Reading The Meter – 130Q-23, Figures 4,5)

a. Electrical energy is the amount of work that can be done by voltage and current over a specific period of time.
b. The unit for measuring electrical energy is the watt-hour (more commonly specified as kilowatt hours which is 1000 watt hours); it is usually designated by the letters kWh.
c. The mathematical relation between voltage, amperes, resistance, and electrical energy is:

1) kWh = W X T

Where,

W = Power (watts)
T = time (hours)

Example: The use of 1,000 watts for 5 hours =

$\text{kWh} = 1{,}000 \text{ watts} \times {}^{1\text{ kW}}/_{1{,}000\text{W}} \times 5\text{hrs} = 5\text{kWh}$

5. Power

a. Electrical power is the amount of work that can be done by voltage and current.
b. The unit for measuring electrical power is the watt; it is usually designated by the letter W.
c. A watt of power is equal to one volt pushing one ampere of current through a conductor with one ohm of resistance.
d. The mathematical relation between power and voltage, resistance and amperes is:

1) W = A X V

Where,

W = power (watts)
A = current (amperes)
V = electrical potential (volts)

e. Example of Usage

1) Most household/farm shop appliances and equipment are rated in watts (see the nameplate or manufacturer's specifications). Knowing the rating in watts and the voltage to be used (normally 120 or 240), the flow of current in the circuit for the appliance/equipment can be calculated.
2) You have purchased a 120 volt plug-in electric space heater for use in your shop. It is rated at 400 watts. How much current will the heater draw?

W = A X V

Or,

A = W divided by V

Where,

W = 400 watts
V = 120 volts

Therefore,

$A = {}^{400W} / {}_{120V} = 3.33$ A (amperes)

f. The mathematical relation between power/watts and voltage, resistance and amperes can be rewritten as:

1) W = A X V

And,

V = A X R

Therefore,

$W = A^2 X R$

C. Ohm's Law (Figure 130Q-1, Page 130Q-20)

1. The physicist, George Simon Ohm, discovered that the flow of electrical current through a conductor is directly proportional to the electromotive force that produces it and inversely proportional to the resistance in the conductor.

   a. If the resistance to electron flow through an electrical device is cut in half, the current amperage doubles.
   b. If the resistance remains constant, but the voltage is doubled, the current amperage doubles.

2. This relationship is expressed in Ohm's law as E = IR or V=AR

   a. I or A equals current in amperes.
   b. E or V equals potential energy in volts.
   c. R equals resistance in ohms.

D. Types of Electricity

1. Direct Current (DC)

   a. Electrons flow constantly in one direction.
   b. This is the type of electricity produced by all batteries.

2. Alternating Current (AC)

   a. Electrons flow first in one direction and then in the reverse direction at a certain rate of reversal (cycles per second). (In the U.S., 60 cycles per second (60 Hertz) is the standard.)

b. AC current has many advantages over DC, i.e., transformers to increase or decrease voltage can be used only with AC current.
c. Transformers enable electricity to be carried long distances on small wires.

3. Single-Phase Current (Figure 130Q-2)

a. This is the typical current supplied to households and businesses where power requirements are not very high.
b. Single-phase current can be provided by two wires.

4. Three-phase Current (Figure 130Q-3)

a. This type of current is designed especially for large electrical loads.
b. It requires at least three wires.
c. Three-phase current is actually three single-phase currents combined so that peak voltages are equally spaced.

E. Sources of Electricity

1. Friction

a. An electrical charge is produced when certain materials are rubbed together. For example, walking across a carpeted floor or sliding across an automobile seat cover sometimes results in static electricity (buildup of electrical charge without current flow).
b. Static electricity has little practical value; in fact, it tends to be a nuisance or a hazard.
Example: On January 27, 1967, astronauts Virgil Grissom, Edward White and Roger Chaffee entered the first Apollo capsule for a pre-flight test. All three were killed when a fire started by static electricity swept through the Apollo command module.

2. Heat

a. If two dissimilar metals (for example, copper and constantan), are connected, and heat is applied at the junction, electrons will pass from one metal to the other.
b. This is called the thermoelectric process.

c. The thermoelectric process is used in furnaces to sense the presence of heat to hold open the fuel supply. When the furnace goes out, lack of heat causes the current flow to stop which in turn shuts off the fuel supply.

3. Light

a. Some dissimilar materials have the property of producing electrical voltage when the boundary between them is subjected to light (radiant energy).
b. These materials are said to be photovoltaic. Examples are cuprous oxide and copper or an electrode and an electrolyte.
c. Photovoltaic materials are used in remote areas (communications satellites, etc.) where it would be impractical to run in lines or to provide batteries.

4. Pressure

a. Some materials produce electricity when pressure is applied that changes their shape.
b. These materials are said to be piezoelectric. Examples are quartz and Rochelle salt.
c. Phonographs using a crystal cartridge utilize the piezoelectric principle to convert the movement of the needle to an electric signal which is then amplified and played through the speakers.

5. Chemical Action

a. Primary Cells

1) The combination of certain metals in an electrolyte solution will produce electricity, for example, copper and zinc in sulfuric acid.
2) Examples of batteries that produce electricity from primary cells are dry cell (paste-like electrolyte, carbon and zinc electrodes) and mercury batteries.
3) The zinc is used up, the electrons become balanced and the batteries go dead.

b. Storage Batteries

1) These batteries are similar to primary cells except that the process can be reversed and the battery can be recharged.

2) Examples of storage batteries are the lead-sulfuric acid batteries used in automobiles, tractors, etc. and the nickel-cadmium rechargeable batteries used in flashlights, radios, etc.

c. Fuel Cells

1) A container in which fuels react in the presence of an electrolyte and electrons are made available at the negative electrode terminal.
2) Oxygen and hydrogen are used as fuels in space vehicles to produce electricity.

6. Magnetic Action

a. A flow of electrons is produced in a coil of wire which is moving within a magnetic field.

1) The magnetic field can be provided by a stationary magnet.
2) Movement of the wire can be provided by:

a. Falling water turning a turbine shaft
b) Atomic power producing steam which turns a turbine shaft
c) An internal combustion engine turning a shaft.
d) This is the most common method of producing electrical energy in large quantities to serve the home, farm, and business.

130Q-10

ELECTRICAL SAFETY

A. Electrical Hazards

1. Shock and fire are hazards associated with electric current.

   a. Shock refers to the body's reaction to the passing of electrical current through it.

      1) Shock occurs from a fall in blood pressure resulting in a decrease of blood supply, and therefore oxygen, to the brain.
      2) The increasing levels of electrical shock caused by increasing amperage makes it clear that voltage is not the killer, rather amperage is.
      3) Shock hazard from electrical current is expressed in milliamperes. One millampere (commonly called a "milliamp") is equal to one thousandth of an ampere, i.e., A/1000 where A is the electrical current in amperes. The following gives an indication of the physical effects of current flow through the human body:

a) barely perceptible	2 milliamperes	0.002A
b) uncomfortable	5 milliamperes	0.005A
c) muscular freeze	10 milliamperes	0.010A
d) fatal	50 milliamperes	0.050A

   b. Fire may occur when electrical conductors overheat or when a spark is produced when an electric current jumps an air gap between conductors.

2. Terminology Associated with Electrical Hazards

   a. A short is a direct connection between a hot wire and a ground connection, allowing amperage to flow up to the limits of a fuse or wire.
   b. A fault is a leakage of current (a high resistance connection) from a hot wire to a ground connection, which may be of such low amperage that the circuit protection will not trip.
   c. A Ground Fault Circuit Interruption (G.F.C.I.) is a device that measures fault current and automatically opens the circuit at a preset value, usually 5-7 milliamperes. The purpose is to protect people from fatal shock. GFCI should be installed where ever the potential for increased grounding exists such as bathrooms, kitchen counters, garage, or outdoor receptacles.

B. Protection of People and Property

1. General Safety Rules

a. Follow the manufacturer's instructions for installation and use of all electrical equipment.
b. Never disconnect or damage a electrical safety device that is provided by the manufacturer.
c. Do not touch electrical appliances, boxes, or wiring with wet hands.
d. Do not remove the long ground prong from three-prong 120-volt plugs.
e. Discontinue using any extension cord that feels warm or smells like burning rubber.
f. Do not use any switches, outlets, fixtures, or extension cords that are cracked or damaged in any way.
g. Do not place extension cords under carpeting.
h. If a fuse is blown or a breaker is tripped, find and correct the problem before installing a new fuse or resetting the breaker.
i. Do not leave heat-producing appliances such as irons, hair dryers, and soldering irons unattended.
j. Keep metal cases of electrical appliances grounded.
k. Keep electrical motors lubricated and free of grease and dirt.
l. If attempting to rescue a person being electrocuted, touch him only after the circuit has been opened, or use an insulated object to move him off the hot wire.

2. Safety Measures in Electrical Wiring

a. Install all electrical wiring according to the National Electrical Code.
b. Open the circuit before touching any point on the circuit.
c. Do not touch bare wires with hands or tools while the circuit is closed.
d. Do not touch wires together to see if they are hot.
e. Do not touch switches or fixtures with wet hands or while standing on wet ground.
f. Do not connect a new circuit to the breaker box until all the wiring is completed.
g. Do not install fuses or breakers with an amperage larger than recommended, or they will not protect the circuit from overheating.
h. Do not overload a circuit with too many fixtures and outlets.

i. Use only double insulated portable tools or tools with three-prong plugs.
j. Insulate splices with electricians' tape or solderless connectors.
k. Install ground fault interrupters in kitchens, bathrooms, laundry, and outdoor circuits, or wherever moisture may increase shock hazard.
l. Use proper color coding of wires when installing a new circuit.
m. Have the local electrical inspector examine all wiring that you have installed.

3. Product Safety Testing

a. Underwriters Laboratories (U.L.) test sample products, such as electrical appliances and tools, to see if they safely do the job for which they were designed.
b. U. L. lists those products tested indicating that they have performed safely. It is not an endorsement or statement of quality.
c. The manufacturers of these listed products display a U. L. label indicating that they have been tested.

SAFETY IN ELECTRICAL WORK

Observe the following general safety practices in doing all electrical work.

1. Avoid damp working areas. Never handle electrical equipment with wet hands or while standing in a wet or damp place.
2. Protect each circuit. Be certain that each circuit is protected with either a circuit breaker or a fuse of proper amperage.
3. Ground each circuit properly. Each circuit must have a ground (neutral) wire and a grounding wire to be properly grounded.
4. Use ground-fault circuit interrupters (GFCI's). To protect the operator who works outside or in damp locations, make sure the electrical source is protected by a ground-fault circuit interrupter.
5. Ground electrical equipment. All 120-volt electrical equipment should be equipped with a three-prong grounding-type plug or be double insulated. Never cut off a grounding prong just to make the connection work.
6. Disconnect the main switch. Before making any repairs on an electrical circuit, always make certain the current has been disconnected.
7. Correct the source of trouble. Before resetting circuit breakers or replacing blown fuses, correct the cause of the trouble. Repair or replace any equipment that gives a shock when it is used.

8. Purchase safe equipment. Select portable electrical equipment that is grounded with a three-prong plug or is double insulated. Look for the "UL" label, indicating that the equipment has been tested and approved by Underwriters Laboratories, Inc.
9. Review local electrical codes. When rewiring a building, follow the local electrical code.
10. Seek professional aid. Instead of using trial-and-error methods when electrical devices do not function properly, get professional help.
11. Avoid plumbing hazards. Do not locate switches or light fixtures near plumbing fixtures.
12. Inspect and repair cords periodically. Inspect all extension cords and electrical appliance cords periodically for exposed wires, faulty plugs, poor insulation, and loose connections. Correct all hazards found on electrical cords.
13. Open circuits with switches. Never pull a plug from an outlet while the equipment is in operation. This creates an arc and will eventually foul the plug or the outlet, which can cause electrical shock or a possible fire.
14. Never make temporary repairs. Make sure all repairs are as good as new. When splicing wires, be sure all strands are twisted together before soldering, the wires are parallel when using wire nuts, the connections are strong, and the splice is fully insulated.
15. Use electrical cords safely. Do not hang electrical cords on nails or run them under rugs or around pipes. Avoid using extension cords as permanent wiring installations.
16. Do not overload circuits. When new equipment is installed, make sure it is protected by a circuit of proper amperage rating.
17. Unplug electrical tools. Do not leave a tool plugged in when it is not in use, unless it is designed for continuous operation.

CONDUCTORS AND OVERCURENT PROTECTION

A. Electrical Conductors

1. Fundamentals

a. Conductors are materials that provide a good path for electron flow.
b. Conductors used in wiring may be made of copper or aluminum.

1) When the price of copper is high, aluminum may be used.
2) Since aluminum is not as good a conductor as copper, it tends to build up more heat from resistance.
3) Aluminum wire is commonly used for the service entrance but the ends of the wire are coated with an antioxidant paste.

c. Conductors may be solid or made of many strands bundled together.

1) Stranded wire, especially for wire sizes No. 8 and larger, improve flexibility and conductivity.
2) Since electricity travels on the outer surface of wires, stranded wire increases conductivity by providing more total surface area.

2. Sizes of Conductors

a. Conductors are classified into sizes by American Wire Gauge numbers.
b. Common wire sizes run in even numbers from No. 18 to No. 6. The lower the gauge number, the larger the wire size.
c. Commonly used wire gauge sizes and their ampere ratings for copper conductors are presented below.

1) No. 14 is rated for 15-ampere circuits.
2) No. 12 is rated for 20-ampere circuits.
3) No. 10 is rated for 30-ampere circuits.

d. Aluminum conductors require one wire size larger than copper conductors to provide the same amperage.

3. Types of Conductors

    a. Electrical Wire

        1) It is a single conductor.
        2) It may be bare or insulated.
        3) It is generally used for permanent installation in conduit or electrical metallic tubing.

    b. Electrical Cable

        1) It is a protective sheath containing two or more insulated wires.
        2) It may contain a bare ground wire also.
        3) It is generally used for permanent indoor installation.

    c. Electrical Cord

        1) It is a conductor consisting of two or more insulated, stranded wires.
        2) It may have a ground wire.
        3) It is generally used where flexibility is required.

B. Classification of Conductors According to Use

1. Types of Wires

    a. Type R wire is insulated with rubber and is used for indoor installation.

        1) Type RH is used in dry locations with high temperatures.
        2) Type RHW is used in wet locations with high temperatures.

    b. Type T wire is insulated with thermoplastic and is gradually replacing Type R wire.

        1) Type T is used in dry locations.
        2) Type TW is used in dry or wet locations.
        3) Type THHN is used in dry locations with high temperatures.
        4) Types THW and THWN are used in wet locations with high temperatures.

2. Types of Cables

a. Cable type markings indicate where the cable can be used.

1) Type USE is an underground cable which may be used for service feeders and branch circuits.
2) Type UF is an underground cable which may only be used for feeders and branch circuits.
3) Type NM is a moisture resistant, nonmetallic sheathed cable often referred to by the trade name, Romex and is only used indoors.
4) Type NMC is nonmetallic sheathed cable that is flame retardant and resistant to moisture, fungus, and corrosion.
5) Type SE is a service entrance cable used to carry current into a building. It is also used to serve welders and 220 volt appliances.

b. Other cable markings indicate the size and number of wires in a cable.

1) 12-2 indicates the cable has two No. 12 wires, one black and one white.
2) 12-2 w/g indicates the cable has two No. 12 wires plus a ground wire, one black, one white, and one green or bare.
3) 14-3 indicates the cable has three No. 14 wires, probably one black, one red, and one white.
4) 14-3 w/g indicates the cable has three No. 14 wires, the same as 14-3 cable with the addition of a green or bare ground wire.

3. Types of Cords

a. Parallel cords are commonly used on lamps, radios, clocks, etc. They are available in wire gauge sizes 16 and 18, and have a groove down the center to make separation of the two wires easy.

1) Type SP is insulated with rubber.
2) Type SPT is insulated with thermoplastic.

b. Junior hard-service cords are used on machines, power tools, trouble lamps, etc. They are round and available in wire gauge sizes 16 and 18.

1) Type SJ has rubber outer insulation.
2) Type SJT has thermoplastic outer insulation.
3) Type SJO has oil-resistant rubber outer insulation.

c. Hard-service cords are used similarly to junior hard-service cords, but have a thicker outer cover for rough use. They are available in wire gauge sizes 10, 12, 14, 16, and 18.

1) Type S has rubber outer insulation.
2) Type ST has thermoplastic outer insulation.
3) Type SO has oil-resistant rubber outer insulation.

d. Heater cords have two common types.

1) Type HPN has a thermosetting insulation that can be used in damp places, but is not designed for hard use. It comes in wire gauge sizes 12, 14, 16, and 18.
2) Type HST has either a rubber and asbestos or neoprene insulation that can be used in damp places. It comes in wire gauge sizes 16 and 18.

C. Overcurrent Protection Devices

1. Fundamentals

a. Each wire size is rated to safely carry a certain amount of electrical current.
b. If wires carry current beyond their rated amperage, they will overheat, damaging insulation and a fire could result.
c. Overcurrent protection devices are, therefore, necessary to protect the wires in an electrical system from excessive heat.

2. Fuses

a. Fuses are overcurrent protection devices containing a strip of low-melting-temperature metal, called a link, which is designed to carry the amperage stamped on the fuse.
b. When a circuit is overloaded, an excessive amount of current passes through the link causing it to melt, and thus opening the circuit before the wires are damaged.
c. Two types of fuses are used, plugs and cartridges.

1) Plug fuses are available in ordinary and time-delay types.

a) Ordinary plug fuses range in size from 3 to 30 amperes and are used in circuits which do not have to handle the high starting current required by motors.
b) Time-delay plug fuses range in size from .4 to 30 amperes and are designed to carry temporary current overloads in electric motor circuits.

2) Cartridge fuses are used to protect circuit with ratings beyond 30 amperes and are also available in the ordinary and time-delay types.

a) Ferrule cartridge fuses range in size up to 60 amperes.
b) Knife-blade contact, cartridge fuses are made in sizes higher than 60 amperes.

3. Circuit Breakers

a. Circuit breakers are current overload protective devices that can be reset and used again after an overload.
b. Breakers contain a metal alloy strip through which current must pass. This strip has calibrated amperage indicated on the breaker switch.

1) Excessive heat from a current overload causes the strip to expand and change shape.
2) This action trips the breaker switch opening the circuit.

c. To function properly, the breaker amperage rating must never exceed the circuit amperage rating.
d. Circuit breakers are time delayed, they can handle the extra current of a motor starting in the circuit without tripping.

ACTIVITY:

1. Pass written safety tests on electricity and keep them on file.
2. Observe a demonstration of first aid for electrical shock given by the local fire department.
3. Have each student complete a safety checklist of his or her own home’s electrical system. The local fire department can provide a good checklist.
4. Measure amperage, voltage, and resistance with a volt-ohm-milliampere meter (VOM).
5. Read a kilowatt-hour meter.
6. Work out problems using the formulas of electricity.

7. Identify the different types of fuses and circuit breakers.
8. Replace various fuses and reset a circuit breaker. Locate the emergency cutoff switches in the shop, push them, and reset the breaker to that circuit.
9. Identify the various wires, cables, and cords in the shop by reading their markings.
10. Take apart various electrical cables with a cable stripper.
11. Create a conductor display that can be used as a teaching aid.

Special Material and Equipment:

VOM meter
Samples of wires, cables, cords, fuses, breakers

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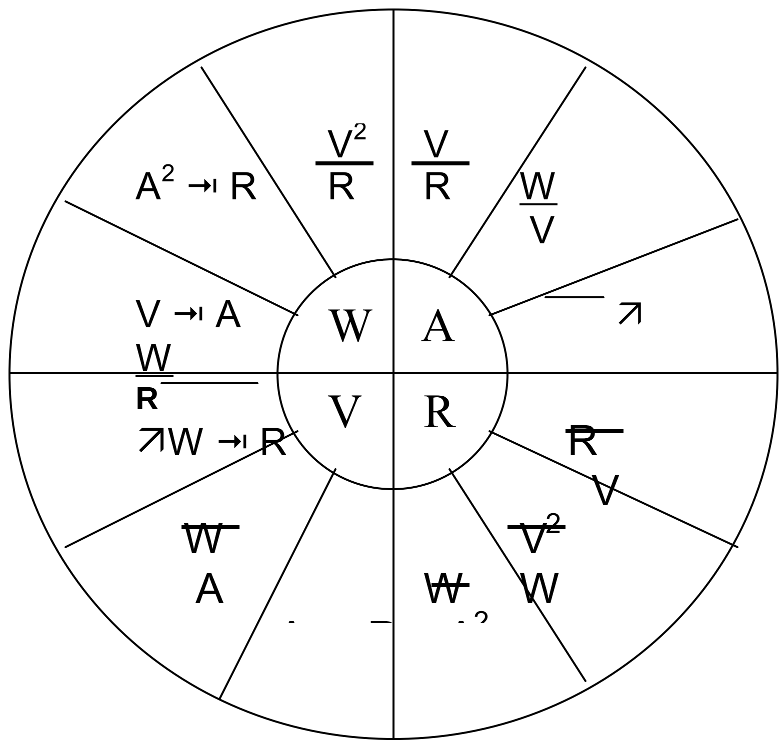
Figure 130Q-1



Using amps and ohms to find voltage

Example: 20A X 6R = <u>120V</u>

4A X 60R = <u>240V</u>

Using amps and watts to find voltage

Example: 1380W / 6A = <u>230V</u>

715W / 6.5A = <u>110V</u>

Using volts and ohms to find amps

Example: 230V / 12R = <u>19.2A</u>

110V / 11R = <u>10A</u>

Using watts and volts to find amps

Example: 6,000W / 120V = 50A

2640W / 240V = 11A

Using volts and amps to find ohms

Example: 240V / 4A = 60R

24V / 9.6A = 2.5R

Using volts and amps to find watts

Example: 240V X 11A = 2640W

115V X 6A = 690W

Figure 130Q-2

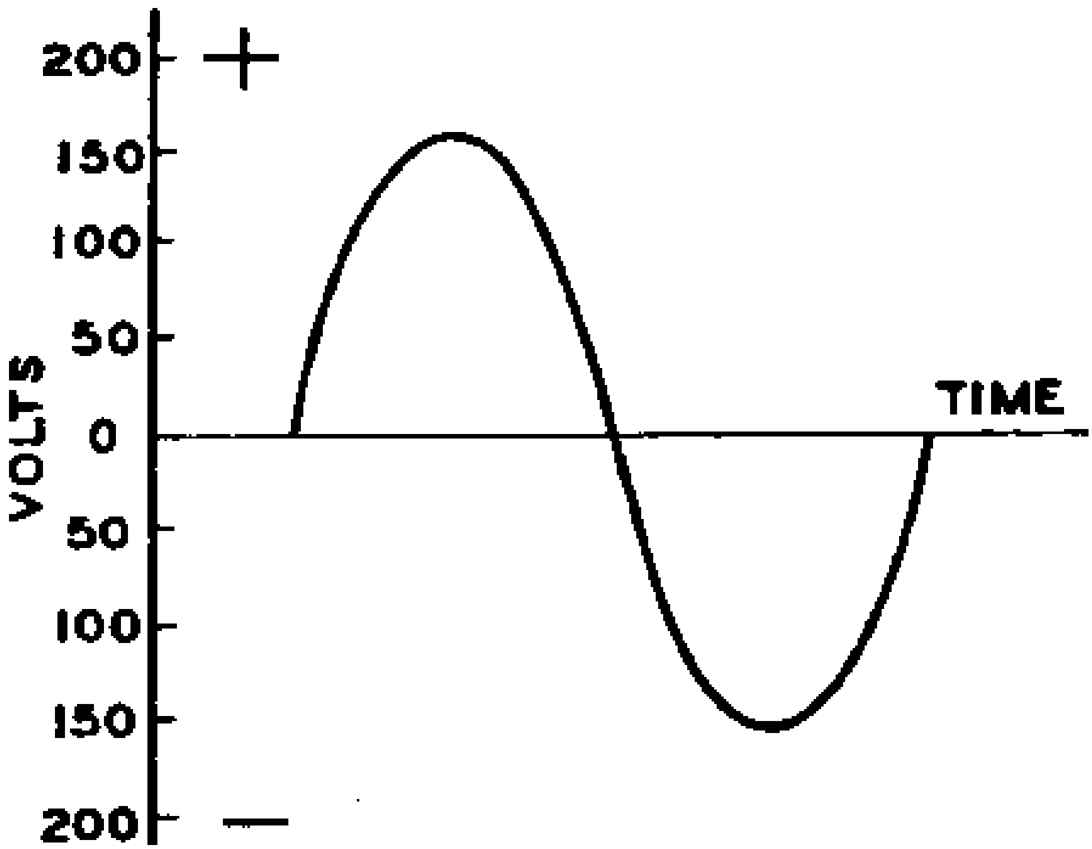


Figure 130Q-2 shows a single cycle of an alternating current

Figure 130Q-3

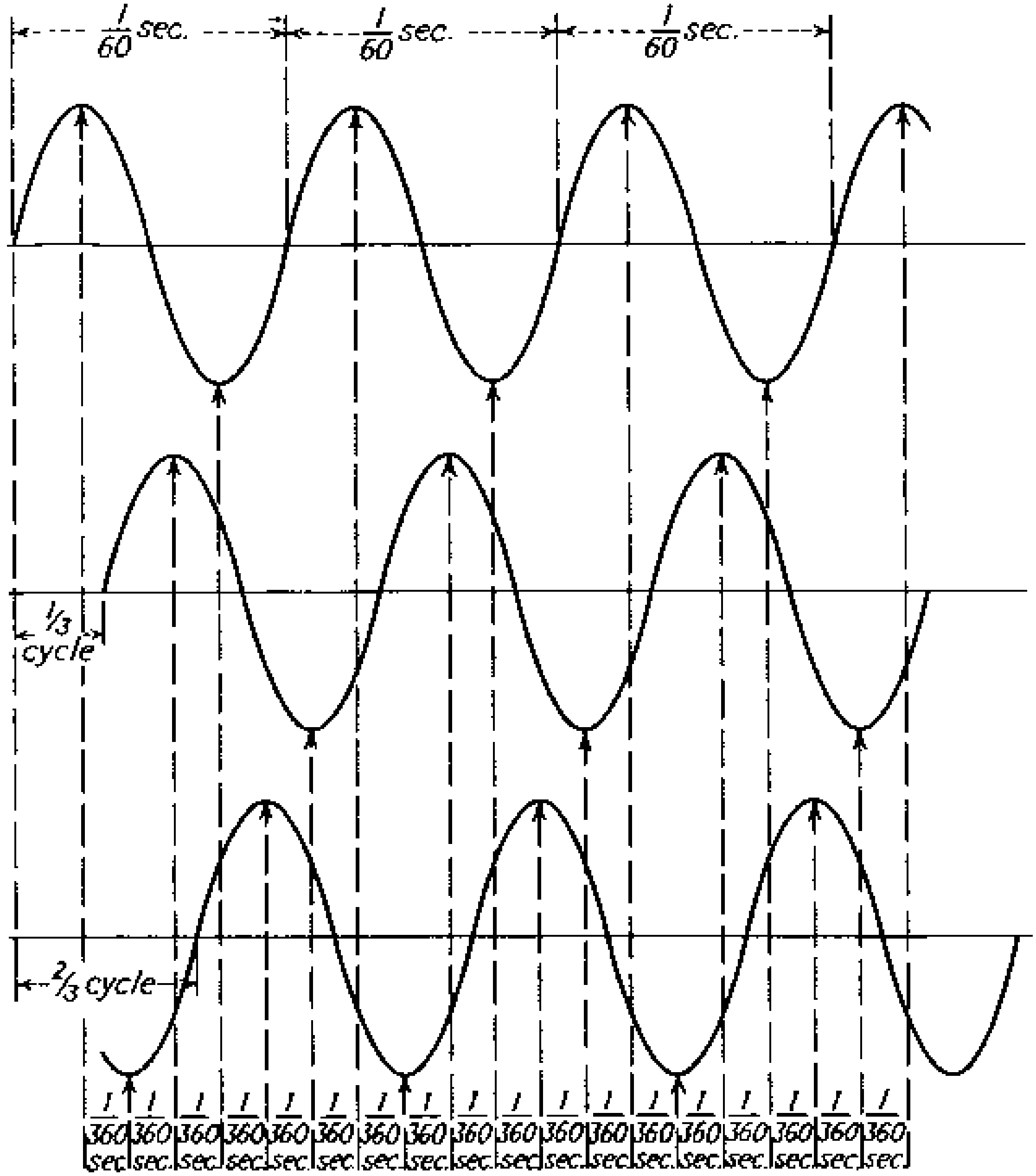


Figure 130Q-3 shows the three single cycles in three-phase electricity. When cycle A is at its' peak, cycle B is on its' way up and cycle C is almost at bottom. When cycle B is at its' peak, cycle C is on its' way up and cycle A is almost at bottom.

Name__________________
Date___________________
Score__________________
Date Passed_____________

ELECTRICAL SAFETY TEST

(Must pass with a grade of 90% or higher before working in the electrical lab.)

Questions 1 – 10 are true or false questions, circle T for true and F for false.

1. T or F   Electrical cord can be placed under a rug for a short period of time.
2. T or F   While not in use, electrical hand tools can be left plugged in.
3. T or F   Under certain conditions an electrical shock from 115 volts can be fatal.
4. T or F   Fires may occur when electrical conductors overheat, due to excess amps.
5. T or F   A short is a direct connection between a hot wire and a ground or neutral connection.
6. T or F   Do not do electrical work in damp or wet conditions.
7. T or F   Do not install fuses or breakers with an amperage larger than recommended wire size.
8. T or F   It's alright to use green wire for the power lead.
9. T or F   Each convenient outlet needs to be properly grounded.
10. T or F   Local electrical inspectors have the final say on new house and shop wiring in their district.

Short answer

11. What is the theory of electricity?
12. Do not connect a new circuit to the breaker box until ______________________?
13. At what amperage does muscular freeze occur?
14. Which is more dangerous, the voltage or the amperage.
15. When is horseplay allowed in the shop?
16. When can power tools be left plugged in over a long period of time?
17. When are temporary repair allowed?

READING THE METER

Reading the meter from left to right

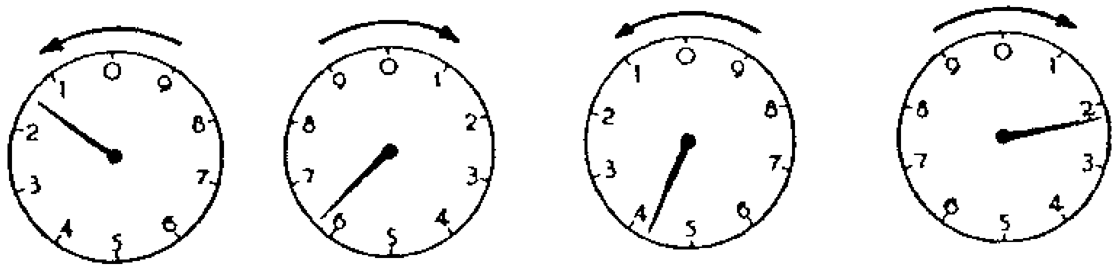


Figure 130Q-4 reads 1642 kWh

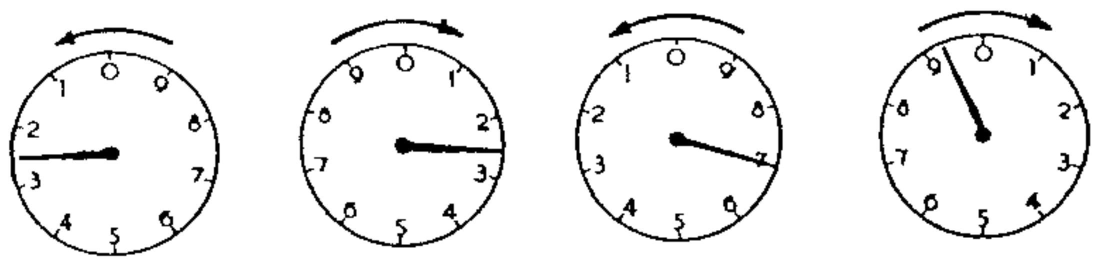


Figure 130Q-5 reads 2269 kWh

Step 1 Minus the first reading (1642 kWh) from the second reading taken a month later (2269 kWh), gives you the current kWh reading (627 kWh).

$$\begin{array}{r} 2269\ \text{kWh} \\ \underline{-\ 1642\ \text{kWh}} \\ 627\ \text{kWh} \end{array}$$

The average cost of electricity in Idaho is 5.5 cents per kWh

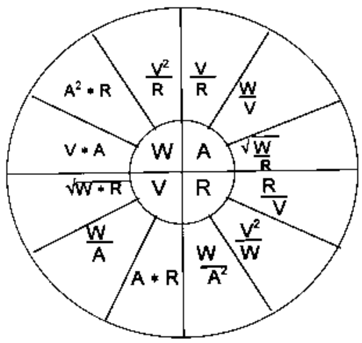
Step 2 Therefor, 627 kWh X 5.5 cents = 34.49$

What would be the cost of operating a 1750W electric heater for 24 hours, if the cost of electricity is 5.5 cents per kWh. Assume the heater operates for 26 minutes an hour.

$$\text{Cost} = 1750\text{W} \times 24\text{hr} \times \frac{26\text{min}}{1\text{hr}} \times \frac{1\text{hr}}{60\text{ min}} \times \frac{1\text{kW}}{1000\text{W}} \times \frac{5.5\text{cents}}{\text{kWh}} = 100.1 \text{ cents or } \$1.00$$

130Q-25

Name______________
Date_______________
Score______________



WORKSHEET, OHMS LAW AND POWER PROBLEMS

Using ohms law and the pie chart, answer the following questions. (SHOW YOUR WORK)

1. How many volts will be required to push 4 amps of current through a resistance of 12 ohms?
2. How many watts are produced from a heater which is drawing a current of 7 amps? The heater has a resistance of 11 ohms.
3. Find the current flow through a 25 ohm resistance if the source voltage across the resistance is 120 volts.
4. What size of resistance is required to produce 1500 watts with a current flow of 12 amps?
5. Find the voltage required to produce 500 watts through a 11-ohm resistance.
6. How much wattage is produced in a 5-ohm resistance if the voltage across the resistance is 120 volts?
7. How much current flow is required to produce 300 watts in a 20-ohm resistance.
8. What resistance will produce 1,000 watts of power when 120 volts is connected across the resistance?

ANSWER SHEET

Electrical Safety Test

1. F
2. F
3. T
4. T
5. T
6. T
7. T
8. F
9. T
10. T

11. The flow of electrons, threw a conductor, from a positive to negative charge.

12 all wiring is completed.

13 10 milliamps

14 Amperage

15 Never

16 Never

17 Never

Ohms Law (worksheet)

1.	4A	X	12R	=		48V
2.	$7A^2$	X	11R	=		539W
3.	120V	/	25R	=		4.8A
4.	1500W	/	$12A^2$	=		10.4R
5.	500W	X	11R	=	↗16500 =	74.2V
6.	$120V^2$	X	5R	=		2,880W
7.	300W	/	20R	=	↗6000 =	3.88A
8.	$120V^2$	/	1,000W	=		14.4R